

Weather Theory

Warm air rises because heat causes air molecules to spread apart. As the air expands, it becomes less dense and lighter than the surrounding air. As air cools, the molecules pack together more closely, becoming denser and heavier than warm air. As a result, cool, heavy air tends to sink and replace warmer, rising air. Every physical process of weather is accompanied by, or is the result of, a heat exchange.

Standard sea level pressure is defined as 29.92 "Hg and a standard temperature of 59 °F (15 °C). This is the standard throughout all of aviation. As altitude increases, atmospheric pressure decreases. On average, with every 1,000 feet of increase in altitude, the atmospheric pressure decreases 1 "Hg. As pressure decreases, the air becomes less dense or thinner.

Differences in air density caused by changes in temperature result in a change in pressure. This, in turn, creates motion in the atmosphere, both vertically and horizontally, in the form of currents and wind. High-pressure systems are generally areas of dry, descending air. Good weather is typically associated with high-pressure systems for this reason. Conversely, air flows into a low-pressure area to replace rising air. This air usually brings increasing cloudiness and precipitation. Thus, bad weather is commonly associated with areas of low pressure.

The stability of the atmosphere depends on its ability to resist vertical motion. A stable atmosphere makes vertical movement difficult. In an unstable atmosphere, small vertical air movements tend to become larger, resulting in turbulent airflow and convective activity. Instability can lead to significant turbulence, extensive vertical clouds, and severe weather.

Rising air expands and cools due to the decrease in air pressure as altitude increases. The opposite is true of descending air; as atmospheric pressure increases, the temperature of descending air increases as it is compressed. Adiabatic heating and adiabatic cooling are terms used to describe this temperature change.

The rate at which temperature decreases with an increase in altitude is referred to as its lapse rate. As air ascends through the atmosphere, the average rate of temperature change is 2 °C (3.5 °F) per 1,000 feet.

Clouds with extensive vertical development are cumulus clouds that build vertically into towering cumulus or cumulonimbus clouds. Towering cumulus clouds indicate areas of instability in the atmosphere, and the air around and inside them is turbulent. These types of clouds often develop into cumulonimbus clouds or thunderstorms. Cumulonimbus clouds contain large amounts of moisture and unstable air and usually produce hazardous weather phenomena, such as lightning, hail, tornadoes, gusty winds, and wind shear. To pilots, the cumulonimbus cloud is perhaps the most dangerous cloud type.

Unstable Air

Cumuliform clouds
Showery precipitation
Rough air (turbulence)
Good visibility, except in blowing obstructions

Stable Air

Stratiform clouds and fog
Continuous precipitation
Smooth air
Fair to poor visibility in haze and smoke

Weather Theory

What is a characteristic of stable air?

- Stratiform clouds ✓
- Cumulus clouds
- Unlimited visibility

What are characteristics of a moist, unstable air mass?

- Poor visibility and smooth air.
- Stratiform clouds and showery precipitation.
- Cumuliform clouds and showery precipitation. ✓

If an unstable air mass is forced upward, what type clouds can be expected?

- Stratus clouds with considerable associated turbulence.
- Clouds with considerable vertical development and associated turbulence. ✓
- Stratus clouds with little vertical development.

What effect does high density altitude have on the efficiency of a UA propeller?

- Density altitude does not affect propeller efficiency.
- Propeller efficiency is increased.
- Propeller efficiency is decreased. ✓

What are the characteristics of stable air?

- Good visibility and steady precipitation.
- Poor visibility and steady precipitation. ✓
- Poor visibility and intermittent precipitation.

What are characteristics of unstable air?

- Nimbostratus clouds and good surface visibility.
- Turbulence and good surface visibility. ✓
- Turbulence and poor surface visibility.